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**NETLOGO TEACHERS' COURSE:
A WEB-BASED SELF-LEARNING COURSE ON LOGO
(OR WHEN THE WEB ENTANGLES THE TURTLE...)**

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The paper discusses a WWW course on Logo for teachers, developed recently in the frames of the European NETLogo Initiative. The purpose of the course is twofold: to demonstrate how Logo applications (microworlds) can support learning in different subject areas, and, to enable teachers experience the Logo programming language and Super Logo environment and motivate them to become developers with Logo themselves. The course content is organized, respectively, in two parts – Logo applications and Logo core. The course is intended and designed for self-learning. It utilizes hypertext and hypermedia as content presentation medium and WWW as main delivery platform. An off-line (CD) version of the course is also available. This paper focuses particularly on the Logo Core content and on the Web design issues: course structure and organization and navigation strategies.

1. Introduction. The scope of the NETLogo Project¹ is the establishment and operation of a European WWW reference point for the use of open-ended educational environments [4]. The result was the *NETLogo: The European Educational Interactive Site* [3]. This paper discusses the *NETLogo Teachers' Training course*, which is part of the *NETLogo Teachers' Educational Center*. The objective was to develop a self-learning course for teachers in the use of Logo, which covers the basics of the Logo programming language and various Logo applications, integrating also pedagogical issues on using Logo in the classroom. The course was designed and developed by a Bulgarian² and a Hungarian team³ in cooperation with the NETLogo partners⁴. It utilizes hypertext and hypermedia technologies as means for content organization and presentation and WWW as main delivery platform. The fully functional version of the course will be served over the Internet via the NETLogo Web server. Course materials with slight modifications are also available on CD-ROM.

¹The NETLogo project (<http://www.netlogo.org>) was set up within the framework of the European Educational Multimedia Programme (European Commission, 1997-1999).

²The course content, dealing with Logo programming, and the overall Web design and development of the course was done by a team, including the authors of this paper.

³The course content, dealing with the Logo applications, was developed by Marta Turcsanyi and Andor Abonyi-Toth

⁴The list of the NETLogo partners is available from <http://www.netlogo.org>

2. Course overview. The NETLogo course is a self-learning course for teachers. No special tutoring, formal testing, assessment or certification is assumed. The learning units are developed in such a way as to offer enough material for exercising and self-checking. The user interface has been designed to provide an intuitive orientation in the course and easy access to course materials.

The most natural way to work in the course is to have two windows open at the same time: the Web browser's window, displaying the course material, and the Logo window (preferably Super Logo) – to experiment. Copying, pasting and modifying code from the course window to the Logo window is envisaged.

2.1. Target group. The course is intended for primary and lower secondary school teachers who want to stimulate and facilitate creative learning in their classrooms by involving their students and themselves in attractive and engaging activities with Logo.

2.2. Goals and objectives. The course has two major goals:

- to demonstrate how Logo can be applied to support learning in various subject domains: by exploring ideas and constructing knowledge while investigating, modifying and extending Logo microworlds;
- to motivate and help teachers acquire knowledge and skills in Logo language and environment and become developers with Logo themselves.

After completing the course the teachers are expected to be:

- fluent users of existing Logo applications – able to tune them according to their needs and integrate them in a meaningful way in the learning context;
- developers with Logo – able to design and develop Logo applications by themselves.

As an extra value, the course demonstrates an innovative use of the WWW for teachers for learning-related purposes and provides stimuli and context to increase the teachers' Internet competence.

3. Course design. This section discusses the main design issues concerning the course [1]. The user profile is the starting point for the design decisions which have been made.

3.1. User profile. We may categorize the users of the course as mainly PC users, who have some basic skills and experience with computers, limited to the usage of some popular application programs such as word processors and web browsers. We also assume that users' computer configuration includes the wide used displays and video cards, which support at least 800×600 graphics resolution with 256 colors and is equipped with CD-ROM drive or network connection.

3.2. Course structure and content presentation. The course content is organized into two main parts: *Logo Core* and *Applications*, with thematic links between them. Each part is divided into several *sections*. Each section comprises of a number

of *units (lessons)*. Each unit has a pre-defined internal structure. The *Applications* deal with applications of Logo in five different subject domains: *Language, Geometry, Arithmetics, Drama and Problem Solving*. Each application unit is based on a pre-defined microworld, which is meant to be used and configured by teachers. While exploring this part, the learner's attention is focused mainly on the subject domain and its simulation, not on the underlying instrument itself – the Logo language.

The purpose of the *Logo Core* is to acquaint the learners with the Logo language and (Super Logo) environment and to help them better understand the examples from the *Applications*. While the learner works with the Applications, she/he acts primarily as a user of already developed applications. Movement to the Logo core is a step, which brings the learner closer to the implementation details and thus, closer to the Logo language and environment. Here, the acquired knowledge should give the learners ability to develop their own applications.

Most of the course units are accompanied by *additional resources*: pre-developed microworlds for the *Applications*, and pre-developed Logo projects and configuration files for the *Logo Core*. The learner is expected to run, explore, modify and/or extend them while working on the course. The presence of supplementary course materials – *additional resources* – requires an easy access to them with explanations how to download, setup and configure the Logo environment and the examples. These requirements are satisfied by including a *Resources* section in the course WWW site.

The supposed prior experience of the learners and the capabilities of their computer configuration and network bandwidth, enforced avoiding the use of sophisticated multimedia technologies for the course development. Two main types of media – text and images are used to represent the main part of the course materials. Sound is used in some of the projects and microworlds accompanying the course units.

3.3. Navigation. The navigation strategy is derived from the previously outlined user profile. The main guideline the designers have followed is to allow the users to navigate through the course in a natural way, not extremely different from the way they are used to (having in mind their basic computer skills). This is why a “Windows Explorer”-like metaphor has been adopted for the main navigational instrument. The learners can quickly and easily – in maximum three clicks – go to the desired place in the course.

The second factor is the need for different paths for the users with different level of competence and at different stages of the learning process. The user can choose her/his own path through the course content depending on her/his background, personal goals, current knowledge, and interests. For example, one teacher may choose to skip the *Logo Core* part because she/he is highly skilled in Logo language and to go directly to *Applications* or vice versa.

The navigation in the course is designed at three levels:

- Global – through the course site
- Local – through the course parts, sections and units

- Internal – within a course unit

3.3.1. Global navigation. The navigation through the course site is supported by the following facilities: the primary navigation bar and by three buttons: ‘*Course Map*’, ‘*Help*’ and ‘*About*’.

The primary navigation bar. The Course Web site has five main components (entry points): *Overview*, *Getting Started*, *Content*, *Glossary*, *Resources*. They are accessible by clicking the corresponding buttons of the *primary navigation bar* (Fig. 1), which is located at the top of the course web pages and is always visible.

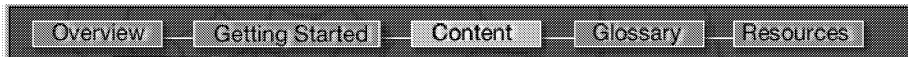


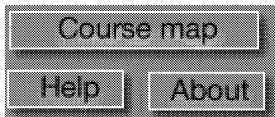
Fig. 1. The primary navigation bar

The meaning of each entry point is:

- *Overview.* Gives a short overview of the course, the intended target group, course goals and objectives, philosophy, content and structure, and credits. This is the first page, which the user sees when she/he enters the course.
- *Getting Started.* It is an important part intended to give the user all the information needed to develop a strategy for working in the course. After reading this part, the learner should be able to go to the desired part of the course and to be informed about the global, local and internal navigation. This part gives also a detailed description of how the course material is organized using the WWW as a presentation media.
- *Content.* This is the largest and the most important part of the NETLogo course Web site. It presents the course content and provides local navigational facilities for accessing the course sections and units. These facilities are described in details further.
- *Glossary.* The Glossary is a useful reference containing a list of the main concepts, terms and primitives used in the course materials. It is compiled on the base of the course content and the Super Logo Help files. The Glossary items are sorted alphabetically and are referred to from within the course units. The navigation within the Glossary is implemented by a speed bar in the top of the Glossary, containing all the letters from the alphabet.
- *Resources.* This part provides access to the additional rresources (learning aids) for the course, namely:
 - *Course Examples* (the complete set of microworlds for all application units);
 - *Super Logo Demo version and Limited Super Logo Help* (for practicing in the course);

- *References* (used while producing the course materials);
- *Logo Books and Magazines* (a link to the relevant section in the NETLogo Information Center).

‘Course map’, ‘Help’ and ‘About’ buttons.



They are located in the down-left part of the page. The *Course map* button displays a map of the course content (Fig. 2), which depicts the names and relative position of all course items. Clicking on an item loads the first page of its presentation.

The *Help* button is linked to a context sensitive on-line help, related to the Course Web site. The *About* button provides information about the authors and developers of the NETLogo course.

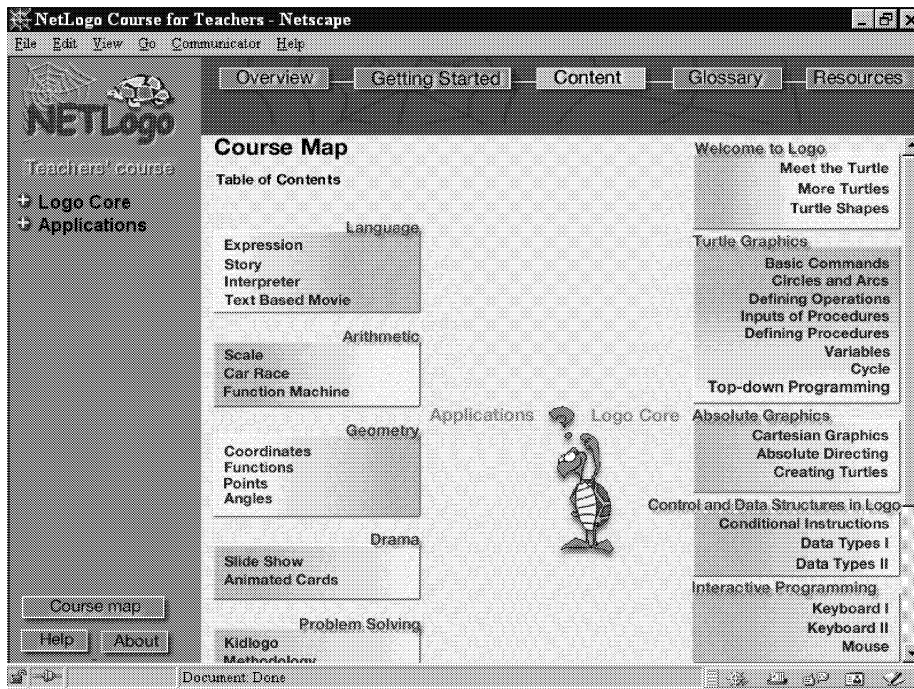


Fig. 2. The Course Map

3.3.2. Local navigation. By pressing the Content button from the primary navigation bar the user can browse and explore the course materials. Now the screen is divided vertically into two parts (Fig. 3, Fig. 4). The left part displays the main navigation facility – the Navigational tree – where the desired unit can be selected. The right part is the place where the content of the selected unit is displayed.

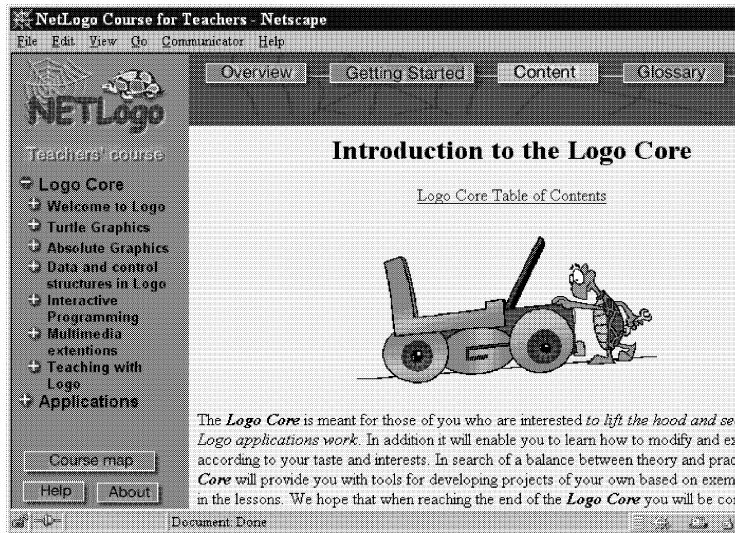


Fig. 3. When a course *part* is selected

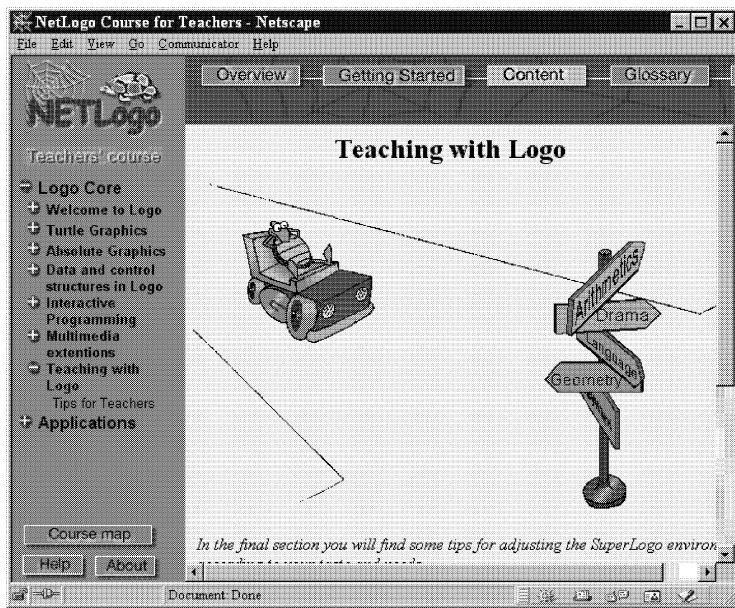


Fig. 4. When a course *section* is selected

The Navigational tree. The course structure (parts, sections and units) is directly mapped to the navigational tree (Fig. 3, left), which follows a *Microsoft Windows Explorer*-like style and provides the same functionality. When an item in the navigational tree is clicked upon, the corresponding content is displayed in the right part of the screen. The content depends on the kind of the item. If it is a course part, e.g. *Logo*

Core (Fig. 3) or a *section*, e.g. *Teaching with Logo* (Fig. 4), an explanatory page for this item is displayed. If it is a unit, e.g. *Meet the Turtle* (Fig. 5), the name of the unit on the left is marked with and is colored in white, and its content is displayed on the right.

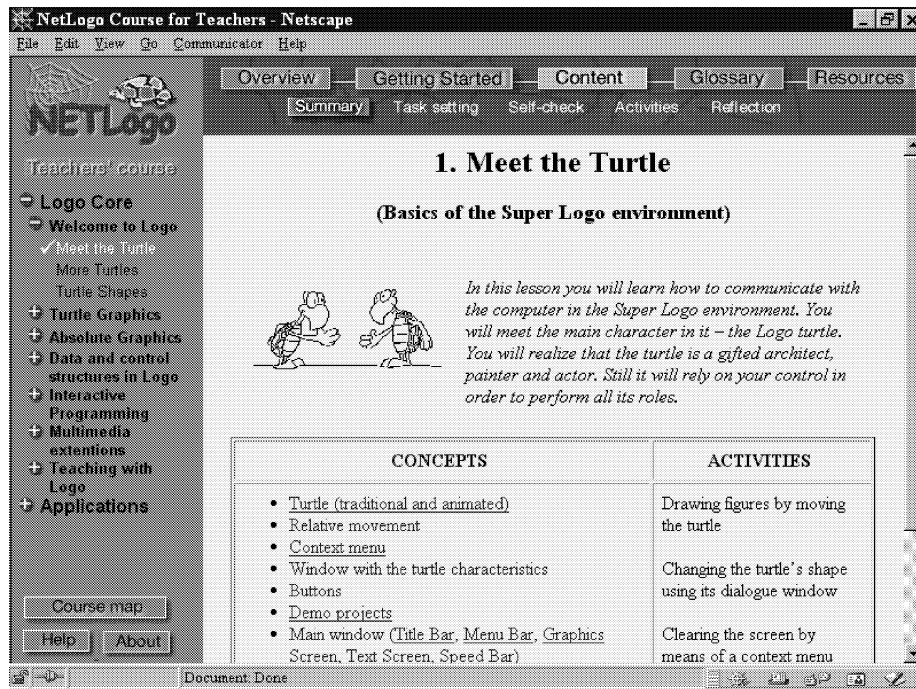


Fig. 5. When a course unit is selected

3.3.3. Internal navigation. Secondary navigation bar. It reflects the internal structure of the units and is different for the two course parts – Logo Core and Applications. *The internal structure of each application unit consists of: Summary, Model, Case Studies, Enhancement and References* (Fig. 6).

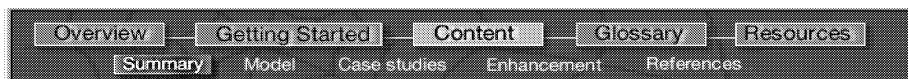




Fig. 6. Secondary navigation bar for Applications

The units in the Logo core part have the following internal structure: *Summary, Task setting, Self-checking, Activities, Reflection* (Fig. 7).



Fig. 7. Secondary navigation bar for Logo Core

To switch between the different components of the internal structure, the user may either follow the implicit sequence of the buttons in the secondary navigation bar or choose the  or  buttons in each content page.

3.3.4. Context Help (related to the course content). Another type of links embedded in the course pages are links attached to Logo concepts and primitives. They link a word to a Glossary item. When such links are traversed, a new small window is opened with the explanation of the word, as it appears in the Glossary.

3.4. Communication and Administration Facilities. The NetLogo Teachers Course is part of the NETLogo Project site, which provides facilities for user registration and tools for communication and collaboration, in both synchronous and asynchronous mode. The designers of the NETLogo site decided that the course users should use these already provided facilities instead of offering them course-specific registration and communication tools.

4. Logo Core Content. The initial idea behind the Logo Core was to meet the curiosity of those teachers who would like *to lift the hood and see how* the Logo applications *work*.

Approaching the design of the Logo core from two different aspects (the emphasis being on the language vs. the emphasis on the programming environment) we finally did it in such a way that the users would be able *to voyage* between the interface and the programming language and to do this with a learning goal in mind.

The course is structured into six modules. We shall consider them from both aspects: the **informatics topics** (supposed to cover the basics of Logo as a language and an environment) and the projects they were introduced with.

Direct manipulation in Super Logo

Informatics topics:

- Basics of Super Logo Environment
- Creating new turtles in a dialog mode. Working with multiple turtles
- Creating turtle's shapes with the Image Editor

Projects:

• Some basic instructions for controlling the movement of the turtle are presented by buttons together with a special *MiniDemo* button which gives an idea about the potential of the environment in terms of the characteristics of the turtle, text animation and sound.

• Several turtles with the shape of cars are created to participate in a motor race. A further version of the motor race is with cars whose wheels are turning.

Turtle graphics

Informatics topics:

- The basic turtle graphics commands.
- The notion of a cycle
- Arithmetic. Variables. Metaphors.
- Defining procedures.

- Procedures with inputs. Tail recursion.
- Defining operations
- Top-down programming

Projects:

- Drawing stylized letters, carpets, regular polygons, houses, figures consisting of circles and arcs, and more complex structures (including self-similar ones) using the above figures as building blocks;

- Calculating arithmetic expressions directly and step by step to check the priority of operations.

- Designing, drawing and running an electronic chronometer.

At this stage the users start working with the language by entering commands to control the relative displacement and turning of the turtle. They draw figures on the screen by using various characteristics of the turtle pen. The way arithmetic operations are presented in Logo is shown and their execution is visualized by *function machines*.

How variables of text and image type are defined is demonstrated by means of the language and the environment alike. The same applies to the way procedures are defined, edited and debugged.

Procedures with inputs and tail recursion are introduced as a very convenient way to describe fractal-like figures.

The style of top-down programming is illustrated in the design of an electronic chronometer.

Absolute graphics

Informatics topics:

- Controlling the turtle in a Cartesian way
- Absolute directing of the turtle
- Creating turtles by means of the language

Projects:

- Drawing stylized pictures presented as a set of points specified by their Cartesian coordinates. Editing the procedures for drawing the pictures so as to get their symmetric images with respect to the coordinate axes.

- Directing the turtle in an absolute direction or towards a specific point is introduced in the context of a project in which the turtle plays the role of a space-pilot traveling from star to star.

- Generating multiple turtles by means of the language is demonstrated in a model of the well-known *four-bugs problem* and variations on it. This problem is rich in variations – various types of behavior are simulated in terms of human relations, or according to the laws of physics.

Control and data structures

Informatics topics:

- Logic Expressions. Conditional instructions. Predicates – primitives and user-defined.

- Words, Lists and Images. Operations on them.

Projects:

- Simulating the behavior of various creatures: turtles, bees, etc. depending on their location.

- Generating a *Character sketch* in which the computer tells you what kind of person you are (your name appearing as an acronym) based on a list of words for human qualities – for each letter of the name a word from the list starting with that letter appears.

A more systematic presentation of the logic of Logo and its control structures is presented. The pursuit of making the logic expressions more readable motivates the introduction of user-defined predicate operations.

The data types in Super Logo are systematized together with the operations on them. The connection between the words and images as sequences of characters and frames, respectively, is demonstrated in the context of a project generating special graphic effects with the user's name. With the introduction of lists, the project is developed in producing a user's character sketch.

Interactive programming

Informatics topics:

- Communication by keyboard (in a program)
- Communication by mouse (in a program)

Projects:

- Transmitting messages by using the Morse code of the key pressed on the keyboard.
- The *Eater* game, in which the player can control a greedy creature by the arrow keys.

- Creating a Graphic editor for drawing in *free hand style* by means of the mouse.

Options for choosing the color and width of the pen, the pattern of the trace together with automatic drawing of geometric figures are presented by means of buttons. The project is further developed and enriched by assigning the functions of the buttons to turtles that have button-like shapes.

More advanced multimedia features

Informatics topics:

- Working with sound and music
- Multimedia extensions of Super Logo Projects
- Creating a virtual piano, in which each key is a turtle playing a specific note when pointed by the mouse.
- Creating multimedia cards with animated elements on a music background (performed by means of Wave file).

Teaching with Logo

Informatics topics:

- Tips for adjusting the environment according to the needs of the teachers
- Analysis of Logo both as a programming language and as an educational philosophy.

The new role of the teacher equipped with a computer, a role of Columbus, daVinci or Prometheus is discussed based on the experience in Bulgaria and other countries. Some lessons learned from successes and failures are conveyed.

5. The structure of the lessons.

Summary – an idea (in a jocular form) about what is to be expected in the unit together with a **table** of the new notions, concepts, primitives to be learned, and activities to be carried out hands-on.

Task setting – a lesson presentation in a step-by-step, learning by doing style. The tasks are to be considered in the context of a larger project.

Self-checking – easy problems, aiming at reassuring oneself that the main notions, syntax rules etc. have been acquired.

Activities – a chain of problems with increasing complexity which are: further developments of the lesson's tasks and suggested practices for mastering the content. While the tasks are in fact digested so that the teachers could accumulate self-confidence, the activities are the source which would hopefully give rise to many powerful ideas.

Topics for reflection – relatively short sections on what has been learned in the lesson, how it relates to the rest of the course, how it can be extended, etc.

6. Course implementation. The course is organized, built and delivered using the WWW platform and its supporting technologies. JavaScript is extensively used as main instrument for client-side programming. The entire functionality of the navigational tree and roll-over images is implemented in JavaScript. This approach moves considerable amount of page processing on the client side and results in improved performance and reduced number of server requests. Every JavaScript enabled browser should be suitable to render the page content and execute the scripts.

7. Conclusion. The design decisions for this course have been made having in mind the main task – to develop a self-learning course – and the potential users – mainly primary school teachers. The assumption is that they are powerful learners, but not yet fluent Web users. In Bulgaria the course will be tested with pre-service teachers and primary in-service teachers. Their feedback will be the starting point for course improvement.

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**КОГАТО ПАЯЖИНАТА ОПЛЕТЕ КОСТЕНУРКАТА
(NETLOGO – КУРС ЗА САМООБУЧЕНИЕ ПО ЛОГО,
ПРЕДНАЗНАЧЕН ЗА УЧИТЕЛИ)**

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Статията представя курс за самообучение по Лого, предназначен за учители и реализиран в WWW. Курсът е разработен в рамките на Европейската инициатива NETLogo. Целта му е, от една страна, да демонстрира как Лого може да бъде използван в обучението по различни предмети – чрез подходящи микросветове, а от друга, да помогне на учителите да почувстват духа на езика и мощността на средата Comenius Logo и да ги стимулира да овладеят тези средства, за да могат сами да създават разнообразни проекти и микросветове. Съдържанието на курса е обособено, съответно, в две основни логически части: „Приложения на Лого“ и „Основи на Лого“. Курсът е разработен с помощта на хипермедийни технологии и е достъпен чрез WWW и на CD-ROM. В статията се разглеждат въпроси, свързани със съдържанието на раздела „Основи на Лого“ и с дизайна на курса за WWW.